



**ASSESSMENT OF SMALLHOLDER FARMERS' PREFERENCES AND UTILIZATION OF AGROFORESTRY TREE SPECIES IN KUDAN LGA, KADUNA STATE, NIGERIA**

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**ABSTRACT**

The study assessed farmers' use of trees and agroforestry tree species preference among smallholder farmers in Kudan Local Government Area (LGA) of Kaduna State, Nigeria. A multistage sampling technique was employed to select 75 respondents, and data were collected using structured questionnaires. Descriptive statistics and multiple regression analysis were used for data analysis. The results revealed that 57.3% of the respondents were predominantly male, middle-aged (42.6%), and had low formal education, with inherited land tenure being the most common. Although awareness of government tree planting programmes was low (37.3%), more than half (54.7%) of the respondents had knowledge of agroforestry practices, mainly through extension agents (23.8%) and research institutes (19.0%). Fuelwood production (17.6%), soil fertility improvement (12.3%), and medicinal uses (10.8%) were the major benefits derived from trees. Indigenous tree species such as *Khaya senegalensis* (5.9%), *Faidherbia albida* (5.7%), *Parkia biglobosa* (5.0%) and *Acacia senegal* (5.2%) were the most preferred due to their multiple socio-economic and ecological benefits. Medicinal value (22.2%) and fuelwood (20.9%) needs were the primary reasons for tree species preference. Regression results showed that gender positively and significantly (0.418) influenced tree species preference, while family size had a negative significant effect (-0.195). Major constraints to agroforestry adoption included destruction of trees by animal herders (23.4%), pest infestation (23.4%), and charcoal-driven deforestation (19.1%). The study concludes that smallholder farmers in Kudan LGA have positive attitudes toward agroforestry, but adoption is constrained by institutional, ecological, and socio-economic factors. Strengthening extension services, addressing farmer-herder conflicts, and promoting access to improved tree seedlings are essential for enhancing agroforestry adoption.

**Keywords:** Agroforestry, Species, Preference, Smallholder-farmers, Savanna, Ecology.

**INTRODUCTION**

Agroforestry, defined as the intentional integration of trees with crops and/or livestock, is widely recognized as a sustainable land-use strategy for enhancing ecological resilience, improving soil fertility, and diversifying income sources among smallholder farmers in sub-Saharan Africa (Tama *et al.*, 2025). In the West African savannah landscapes, the deliberate retention and management of woody species within agricultural fields provide multiple ecosystem services, including shade, windbreak protection, nutrient cycling, carbon sequestration, and the provision of food, fuelwood, fodder, and medicinal products (Umeh, 2024; Kuyah *et al.*, 2016). Consequently, agroforestry contributes significantly to food security, climate change mitigation, and livelihood improvement in rural farming systems.

In Nigeria, agroforestry practices are deeply embedded in traditional farming systems, particularly through the preservation of multipurpose indigenous tree species on farmlands. Empirical studies across different agro-ecological zones reveal that farmers' preferences for agroforestry tree species are primarily influenced by direct livelihood benefits and ecological functions. For instance, studies in Bauchi State reported high farmer preference for species such as *Adansonia digitata* (baobab) and *Parkia biglobosa* (African locust bean) due to their contributions to household nutrition, income generation, and soil conservation (Tama *et al.*, 2025). Similar patterns have been documented in Adamawa and Ogun States, where smallholder farmers favor trees that provide food, fuelwood, shade, and medicinal products within mixed cropping systems (Boni *et al.*, 2022; Mustapha & Jimoh, 2012).



These findings underscore the importance of understanding local tree species preferences to ensure the ecological effectiveness and socioeconomic relevance of agroforestry interventions.

Trees play a critical role in agricultural landscapes, particularly in the tropics, where they enhance soil structure, improve water infiltration, and increase the availability of essential nutrients (Borris *et al.*, 2018). Beyond biophysical benefits, trees and woody shrubs provide timber, fibre, fruits, fodder, and fuelwood that support rural livelihoods through direct consumption and income generation (Nyaga *et al.*, 2015). Additionally, tree integration into farmland contributes to carbon sequestration in both above- and below-ground biomass, making agroforestry one of the most effective land-based climate change mitigation strategies (Zomer *et al.*, 2016; Sinclair *et al.*, 2019). As such, incorporating multipurpose trees within arable land systems enhances food and nutritional security while strengthening ecosystem services and climate resilience (Kuyah *et al.*, 2016).

Rural populations play a central role in sustainable land-use management and biodiversity conservation through land-use systems that balance economic, social, and environmental benefits (Garnett *et al.*, 2018). Unlike traditional shifting cultivation systems that involved extensive tree clearing, contemporary agroforestry practices increasingly emphasize natural regeneration and the deliberate planting of tree seedlings alongside annual crops (Reang *et al.*, 2024). In the Sudan–Sahel and Guinea savannah zones of West Africa, naturally regenerated trees remain a primary source of domestic wood, food supplements, medicinal products, livestock feed, and soil fertility improvement (Mulugeta, 2014). However, poor management practices and over-exploitation have reduced tree productivity, contributing to ecosystem degradation, deforestation, and desertification (Mustapha & Jimoh, 2012).

Land-use change and deforestation remain significant challenges in Nigeria. Savanna ecosystems currently cover approximately 75% of the country's land area, while forest cover has declined from about 23.6% historically to 12.2%, with primary forest accounting for only 2.9% (World Bank, 2020; Akinyemi & Ifejika, 2024). Much of this vegetation loss occurred between 2000 and 2013, largely due to agricultural expansion, irrigation development, and infrastructure growth. These trends highlight the urgency of promoting sustainable land-use systems such as agroforestry to curb further environmental degradation while sustaining agricultural productivity.

Despite extensive agroforestry research in southern Nigeria and parts of the northeast, there remains limited empirical documentation of farmers' tree species use and preference in Kudan Local Government Area of Kaduna State, located within the northern Guinea savannah zone. Existing studies, such as that by Mustapha and Jimoh (2012), focused on southwestern Nigeria and did not capture the ecological and socio-cultural dynamics of northern savannah systems. Indigenous knowledge of tree species remains a critical yet under-documented resource for sustainable land management, particularly in the context of climate change adaptation and decolonial approaches to agricultural research (Moyo *et al.*, 2022; Steger *et al.*, 2023).

Therefore, this study aimed to assess farmers' use and agroforestry tree species preferences among smallholder farmers in Likoro community of Kudan LGA, Kaduna State. Specifically, the study sought to identify priority tree species and the underlying reasons for farmer preference. The findings are expected to provide evidence-based insights to support agroforestry planning, extension services, and policy interventions aimed at promoting sustainable land-use and livelihood resilience in northern Nigeria.

## **METHODOLOGY**

The study was conducted in Kudan Local Government Area (LGA), Kaduna State, Nigeria, located in the northern Guinea savannah zone characterized by a mix of annual cropping systems. A total of 75 smallholder farmers practicing agroforestry were purposively selected across the villages of Kudan LGA. A structured questionnaire was administered through face-to-face interviews to gather data on farmers' socio-demographics, tree species known and used, and the farmers' preferences for specific species within their farming systems. Similar approaches have been used effectively in agroforestry research across Nigeria, allowing comparison with existing studies (Tama *et al.* 2025). Farmers were asked to identify all tree species present on their farms and indicate those species they



preferred most for reasons that could include income generation, food value, shade, soil fertility improvement, medicinal use, or other perceived benefits. The questionnaire data were coded and entered into statistical software for descriptive analysis using SPSS. Frequencies and percentages were calculated to summarize socio-demographic data and the occurrence and preference levels of tree species. Preference ranking was conducted by assigning scores to species based on the number of times they were cited as preferred by respondents. This method is commonly applied in studies exploring tree species priorities in agroforestry contexts (Tama *et al.* 2025).

## RESULTS AND DISCUSSION

### Socio-Economic Characteristics of Respondents

The results show that smallholder farmers in Likoro are predominantly male (57.3%), although female participation (42.7%) is substantial. This gender distribution reflects the traditional land ownership and decision-making structures common in northern Nigeria, where men often control farm resources while women contribute significantly to farm labor and tree management. Similar patterns have been reported by Adekunle *et al.* (2019) and Jeminiwa *et al.* (2021) in agroforestry studies across northern Nigeria.

The age structure indicates that most respondents fall within the economically active age brackets of 38–57 years (42.6%), suggesting that agroforestry decisions are largely made by experienced farmers. This supports findings by Mercer and Miller (2018), who noted that middle-aged farmers are more likely to integrate trees due to accumulated farming experience and long-term land-use planning perspectives.

Educational attainment was generally low, with 33.3% having no formal education and 40% having Quranic/Islamic education. Low formal education may influence access to technical agroforestry information and adoption of improved tree species, as earlier documented by Franzel *et al.* (2016) and Ogunjinmi *et al.* (2020).

Land tenure was dominated by inherited land (61.3%), which is favorable for agroforestry adoption since secure tenure encourages long-term investments such as tree planting. This observation aligns with the conclusions of Place *et al.* (2017) and Damnyag *et al.* (2020) that land security significantly enhances farmers' willingness to plant trees.



**Table 1:** Distribution of Respondents based on Socio-economic Characteristics (n=75)

Variables	Frequency	Percentage
<b>Gender</b>		
Male	43	57.3
Female	32	42.7
<b>Age (years)</b>		
18-27	8	10.7
28-37	9	12.0
38-47	13	17.3
48-57	19	25.3
58-67	10	13.3
68 and above	16	21.3
<b>Marital Status</b>		
Single	14	18.7
Married	41	54.7
Divorced	9	12.0
Widowed	11	14.7
<b>Family Size</b>		
1-5	23	30.7
6-10	26	34.7
11-15	20	26.7
16 and above	6	8.0
<b>Educational Level</b>		
No formal education	25	33.3
Adult education	6	8.0
Quranic/Islamic education	30	40.0
Primary education	8	10.7
Secondary education	6	8.0
<b>Years of Framing Experience</b>		
1-10	20	26.7
11-20	22	29.3
21-30	22	29.3
31 and above	11	14.7
<b>Type of Land Tenure</b>		
Inherited	46	61.3
Rented	16	21.3
Purchased	10	13.3
Others	3	4.0

**Awareness on Tree Planting Programme by Government**

As shown in Table 2, majority (62.7%) of the respondents were not aware of any tree planting programme by the government while only 37.3% were aware. This suggests weak extension–farmer linkages and limited outreach of afforestation initiatives in the study area. Similar gaps have been highlighted by Akinwalere and Adekunle (2018), who attributed low participation in government-led tree programs to poor communication and inadequate local engagement.

**Table 2:** Respondent Level of Awareness of tree Planting Initiatives

Awareness tree planting	Frequency	Percentage
Yes	28	37.3
No	47	62.7
Total	75	100.0

**Awareness of Agroforestry Initiatives**

The findings in Table 3 revealed that more than half (54.7%) of the respondents have heard of agroforestry establishment while 45.3% have never heard of agroforestry establishment. The level of



awareness suggests a moderate penetration of agroforestry information among smallholder farmers in Likoro, but it also highlights a significant knowledge gap that may limit wider adoption of agroforestry practices.

The observed awareness level is comparable to reports from other parts of Nigeria, where farmers often practice elements of agroforestry without fully recognizing it as a formal land-use system. For instance, Adekunle and Bakare (2014) and Ogunjinmi *et al.* (2020) noted that many Nigerian farmers retain trees on farms for fuelwood, food, or soil improvement but lack conceptual understanding of agroforestry as an integrated production system. This partial awareness may explain why agroforestry adoption remains largely traditional and unstructured in many rural communities.

**Table 3: Level of Awareness of Agroforestry Initiatives**

Agroforestry/Woodlot	Frequency	Percentage
Yes	41	54.7
No	34	45.3
Total	75	100.0

### Sources of Information about Agroforestry

The major source of information about agroforestry was from state extension agents (23.8%), followed by research institutes (19%), mass media (17.5%) and relatives and friends (14.3%). The results indicate that state extension agents were the major source of agroforestry information among respondents, followed by research institutes, mass media, and relatives or friends. This highlights the continued relevance of formal agricultural extension services in disseminating agroforestry knowledge to smallholder farmers in rural Nigeria. Similar studies have reported that extension agents remain the most trusted and effective channel for promoting tree-based agricultural practices due to their direct interaction with farmers and context-specific advisory roles (Akinwalere & Adekunle, 2018; Ogunjinmi *et al.*, 2020). Research institutes also played a significant role, reflecting the contribution of forestry and agricultural research organizations to agroforestry awareness. However, limited direct contact between research institutions and farmers has been identified as a constraint to wider dissemination of research outputs (Adekunle *et al.*, 2019). The role of mass media, particularly radio, further underscores its importance in reaching rural farmers, as documented by Nwachukwu and Onuekwusi (2017), although its effectiveness is often constrained by limited interaction and inconsistent programming. Information exchange through relatives and friends demonstrates the influence of social networks in agroforestry knowledge diffusion. Informal peer-to-peer learning has been widely recognized as a critical factor in shaping farmers' awareness and adoption decisions (Rogers, 2003). Overall, the findings suggest that strengthening linkages between extension services, research institutions, mass media, and community networks would enhance the effectiveness of agroforestry information dissemination.

**Table 4: Respondents Sources of Information on Agroforestry/ Afforestation**

Source of Information	Frequency	Percentage
State Extension Agents	15	23.8
Village Head/Traditional Ruler	5	7.9
Relative/Friends	9	14.3
Mass Media	11	17.5
Co-operative farmers	6	9.5
Research Institutes	12	19.0
Social Media	5	7.9
Total	63	100.0

### Major Sources of Seedlings for Tree Planting

The major source of seedlings for respondents engaged in tree planting was private nurseries (28.0%), followed closely by research institutes (26.7%), while 20.0% obtained seedlings through non-governmental organizations (NGOs) and other project-based interventions. This pattern suggests a



growing reliance on market-based seedling supply systems, particularly where government nurseries are inadequate or inaccessible. Similar findings in Nigeria indicate that private nurseries often provide more timely and diverse tree species demanded by farmers (Adekunle & Bakare, 2014; Ogunjinmi *et al.*, 2020). The significant role of research institutes reflects their contribution to the supply of improved and quality planting materials, especially for agroforestry species (Franzel *et al.*, 2016). The involvement of NGOs and project-based interventions further highlights the importance of external support in promoting tree planting among smallholder farmers in rural Nigeria (Jamnadass *et al.*, 2015).

**Table 5:** Sources of Tree Seedlings

Sources of tree seedlings	Frequency	Percentage
ADP	11	14.7
Private Nurseries	21	28.0
Government Nurseries	8	10.7
Research Institutes	20	26.7
Others	15	20.0
Total	75	100.0

### Perceived Benefits Derived from Tree Utilization

Majority (17.6%) of the respondents chose production of fuel wood as the main benefits derived from trees, other benefits (13.2%), promotion of soil fertility (11.8%), reduced wind effects (11.8%), herbal/medicinal purposes (10.8%) while the least 7.8% was for poles production. This multifunctional perception of trees reflects the livelihood-oriented nature of agroforestry among smallholder farmers. The prominence of fuelwood is consistent with findings by Arnold *et al.* (2018), who noted that rural households in sub-Saharan Africa prioritize tree species that meet household energy needs. Similarly, the recognition of soil fertility improvement aligns with ecological studies by Garrity *et al.* (2017), which demonstrated the positive effects of parkland trees such as *Faidherbia albida* on soil nutrient cycling and crop yields.

**Table 6:** Benefits Derived from Tree Utilization

Benefits from Trees Utilization	Frequency	Percentage
Production of fuel wood	36	17.6
Promotes soil fertility	25	12.3
Improves productivity	18	8.8
Reduced wind effects	24	11.8
Erosion control	18	8.8
Poles Production	15	7.4
Fodder for Livelihood	19	9.3
Herbal/Medicinal Purposes	22	10.8
Others	27	13.2
Total	204	100.0

Multiple responses

### Tree Specie Preferences

Mahogany and *Faidherbia albida* were the most preferred species with 5.9% and 5.7% respectively. This was followed by Cashew (5.3%), Gum Arabic (5.2%) African locust bean, Rosewood, *Pilostigma thoningii* and *Mangifera indica* with 5.0% each. It was found that respondents had a reasonable clear focus on indigenous trees with clear benefits for fuel wood, soil fertility and herbal/medicinal purposes in their preferences.

Preference for *Faidherbia albida* (Gao) is particularly significant due to its nitrogen-fixing ability and compatibility with crops. This finding corroborates earlier studies by Sileshi *et al.* (2014) and Bayala *et al.* (2020), who reported high farmer acceptance of *F. albida* across West African parkland systems.



Fruit trees such as mango, cashew, citrus, and guava were also widely preferred, reflecting the increasing importance of income diversification and nutrition-sensitive agriculture. According to Jamnadass *et al.* (2015), integration of fruit trees into smallholder systems enhances household income resilience and dietary diversity.

**Table 7: Tree Specie Preferences by the Respondents**

Preference	Frequency	Percentage
Khaya senegalensis (Mahogany)	54	5.9
Azadirachta indica (Neem)	43	4.7
Adansonia digitata (Baobab)	38	4.2
Parkia biglobosa (African Locust Bean)	46	5.0
Vitellaria paradoxa (Shea Tree)	37	4.1
Tamarindus indica (Tamarind)	37	4.1
Bombax costatum (Gurjiya)	39	4.3
Eucalyptus camaldulensis (Eucalyptus)	40	4.4
Faidherbia albida (Gao)	52	5.7
Acacia Senegal (Gum Arabic)	47	5.2
Pterocarpus erinaceus (Rosewood)	46	5.0
Acacia nilitoca (Bagaruwa)	17	1.9
Balanites aegyptiaca (Dessert Date)	44	4.8
Pilostigma thoningii (Kalgo)	46	5.0
Albizia lebbek (Albizia)	31	3.4
Mangifera indica (Mango)	46	5.0
Citrus sinensis (Sweet Oraange)	29	3.2
Citrus reticulate (Tangerine)	45	4.9
Carica papaya (Pawpaw)	38	4.2
Anacardium occidentale (Cashew)	48	5.3
Psidium Guajava (Guava)	34	3.7
Persea americana (Avocado Pear)	22	2.4
Others	32	3.5
<b>Total</b>	<b>911</b>	<b>100.0</b>

Multiple responses

### Reasons for Tree Preference

The result in Table 8 shows that the main reasons for the tree preference are for medicinal purposes (22.2%), for fuel (20.9%), wind break (16.9%), shade (16.7%) and food 12.9%. This highlights the continued reliance on traditional medicine and ecosystem services provided by trees in rural communities.

Medicinal preference aligns with findings by Aguilar-Støen *et al.* (2019), who emphasized the role of ethnobotanical knowledge in shaping agroforestry species selection. Shade and windbreak functions are also critical in the savanna ecology of Kaduna State, where extreme temperatures and wind erosion affect crop productivity, as observed by Bationo *et al.* (2018).

**Table 8: Reasons for Tree Specie Preferences by the Respondents**

Reasons	Frequency	Percentage
Medicinal Purposes	100	22.2
Wind Break	76	16.9
Shade	75	16.7
Food	58	12.9
Erosion Control	31	6.9
Fuel	94	20.9
Fresh Air	16	3.6
<b>Total</b>	<b>450</b>	<b>100.0</b>

Multiple responses



### Willingness to Plant and Nurture Tree Seedlings

As shown in Table 9, more than half (54.7%) are willing to plant and nurture tree seedlings if provided while 45.3% were not willing. This indicates a positive attitude toward agroforestry, suggesting that adoption could increase if key constraints are addressed. According to Pattanayak *et al.* (2017), willingness alone is insufficient without institutional support, access to quality seedlings, and protection measures.

**Table 9:** Respondents' Willingness to Plant and Nurture Tree Seedlings

Willingness to Plant	Frequency	Percentage
Yes	41	54.7
No	34	45.3
<b>Total</b>	<b>75</b>	<b>100.0</b>

### Constraints Faced by the Respondents

The major constraints (23.4%) faced by the respondents were destruction of existing trees by animal herders and insect/pest attacks, followed by unchecked harvesting of trees for charcoal (19.1%), deforestation and Expansion of farmlands leading to deforestation (10.6%) and lack of access to improved trees (8.5%) as shown in Table 10. Similar constraints have been reported by Blench (2018) and Adisa *et al.* (2021).

The issue of charcoal-driven deforestation reflects broader energy poverty challenges, as noted by Alem *et al.* (2020), who linked reliance on biomass energy to forest degradation in West Africa.

**Table 10:** Constraints Faced by the Respondents

Constraints	Frequency	Percentage
Deforestation	5	10.6
Unchecked harvesting of trees for charcoal	9	19.1
Lack of access to improved trees	4	8.5
Expansion of farmlands leading to deforestation	5	10.6
Limited extension service	0	0.0
Destruction of existing trees by animal herders	11	23.4
Insect/pest attacks	11	23.4
Forest fires	0	0.0
Others	2	4.3
<b>Total</b>	<b>47</b>	<b>100.0</b>

Multiple responses

### Socio-economic Factors Influencing Tree Species Preference

Table 11 presents the results of a multiple regression analysis examining the influence of selected socioeconomic factors on the tree species preference among smallholder farmers. The value of adjusted  $R^2$  was found to be 0.25, indicating that approximately 25% of the variation in the tree species preference is explained by the included socioeconomic variables. The findings provide useful insights into the respondents' tree species preference.

The gender of respondent had a coefficient of 0.418 and was found to have a positive and statistically significant at 1% level of significance. This implies that tree species preference differs significantly between male and female farmers. In practical terms, one gender (depending on coding) is more likely to prefer or adopt certain tree species than the other.

Family size (-0.195) was found to be negative and significant at 10% level of significance. This suggests that as household size increases, preference for certain tree species tends to decrease, possibly due to higher consumption needs or preference for high fast yielding crops over trees.

The result shows that gender and family size are key factors that affect tree species preference among smallholder farmers in Kaduna State. This suggests that household dynamics and gender play a more critical role in tree species selection than individual demographic characteristics.



**Table 11:** Socio-economic Factors Influencing Tree Specie Preference

Variable	Coefficients	Standard Error	t-Value	Sig.
(Constant)		0.247	6.591	0.000
Gender	0.418	0.092	3.911	0.000***
Age of Respondents	0.010	0.028	0.093	0.926
Marital Status	0.040	0.049	0.382	0.704
Family Size	-0.195	0.048	-1.842	0.070*
Educational Level	-0.117	0.035	-1.137	0.260
Years of Farming Experience	-0.151	0.044	-1.435	0.156
R <sup>2</sup>	0.315			
Adjusted R <sup>2</sup>	0.254			
F-Value	5.200			

Computed Using SPSS; \*\*\*P<0.01, \*\*P<0.05, \*P<.0.1

## CONCLUSION AND RECOMMENDATION

This study examined farmers' use of trees and agroforestry tree species preference among smallholder farmers in Kudan Local Government Area of Kaduna State. Farmers actively preferred multipurpose, indigenous tree species that support their livelihoods through fuelwood, soil fertility enhancement, medicinal uses, and income generation. The positive perception and willingness of farmers to practice agroforestry indicate strong potential for its expansion and contribution to sustainable land management. However, low awareness of government programmes reflects weak institutional engagement, while socio-economic factors such as gender and household size significantly influence tree species preference. In addition, challenges including farmer–herder conflicts, pest infestations, and deforestation threaten sustainability. Therefore, strengthening institutional support, improving farmer awareness, and addressing socio-ecological constraints are essential to enhance agroforestry adoption and maximize its benefits for rural livelihoods and environmental sustainability. Based on the findings of this study, the following recommendations are proposed:

1. Agricultural extension agencies should intensify agroforestry awareness campaigns and farmer training programs, with emphasis on preferred indigenous and multipurpose tree species suited to the local ecology.
2. Policies and programs should explicitly incorporate gender considerations by promoting inclusive participation of both men and women in agroforestry decision-making, nursery management, and benefit sharing.
3. Government agencies, research institutes, and non-governmental organizations should support the establishment of community-based nurseries to improve farmers' access to improved and locally adapted tree species.
4. Tree planting initiatives should be integrated with conflict-sensitive land-use planning, including the demarcation of livestock routes and promotion of protective measures such as fencing to reduce tree destruction.
5. Enforcement of sustainable forest management regulations and promotion of alternative energy sources should be prioritized to reduce pressure on existing tree resources.
6. Future studies should focus on long-term economic and ecological impacts of preferred agroforestry species and explore participatory approaches to scaling up agroforestry adoption across Kaduna State and similar agro-ecological zones.

## REFERENCES

- Adekunle, V. A. J., Abegunde, V. O., & Yusuf, R. O. (2019). Challenges and prospect of agroforestry adoption among rural farmers in Southwest Nigeria. *Journal of Forest Research*, **30**(2): 785–795.
- Adesina, A. A., & Baidu-Forson, J. (1995). Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea. *Agricultural Economics*, **13**(1): 1–9.



- Adisa, R. S., Adeoye, N. O., & Akanbi, G. O. (2021). Farmer–herder conflict and its effects on natural resource management in Nigeria. *Environmental Management and Sustainable Development*, **10**(3): 45–60.
- Aguilar-Støen, M., Moe, S. R., & Tchoundjeu, Z. (2019). Agroforestry systems and traditional ecological knowledge: Farmers’ perceptions in sub-Saharan Africa. *Agroecology and Sustainable Food Systems*, **43**(5–6): 678–699.
- Akinwalere, O. O., & Adegunle, A. T. (2018). Extension outreach and tree planting behaviour of farm households in Nigeria. *Journal of Agricultural Extension*, **22**(4): 55–68.
- Akinyemi, T. F., & Ifejika Speranza, C. L. (2024). Smallholder farmers’ perceptions of climate change impacts and adaptation strategies in Nigeria: Implications for sustainable agroforestry adoption. *Climate and Development*, **16**(2): 153–168
- Alem, Y., Köhlin, G., & Mekonnen, A. (2020). Residential energy and charcoal demand in sub-Saharan Africa: Evidence from Nigeria. *Energy for Sustainable Development*, **56**: 178–188.
- Arnold, J. E. M., Köhlin, G., & Persson, R. (2018). Woodfuels, livelihoods, and policy interventions: Changing perspectives. *World Development*, **110**: 73–85.
- Bationo, A., Waswa, B. S., Kihara, J., & Kimetu, J. (2018). *Soil fertility management in Africa: A regional perspective*. Springer.
- Bayala, J., Degrande, A., & Teklehaimanot, Z. (2020). Parkland agroforestry systems of West Africa: Their functioning and productivity. *Agroforestry Systems*, **94**(5): 1089–1108.
- Blench, R. (2018). *Conflict between pastoralists and cultivators in Nigeria: Causes, consequences and resolutions*. Kaduna: Sahelian Centre.
- Boni, P. G. *et al.* (2022). Evaluation of factors limiting agroforestry practice and tree species used by agroforestry farmers in Adamawa State, Nigeria. *Net Journal of Agricultural Science*. (netjournals.org)
- Borris, S., Quintana, O. A., & Ryan, C. M. (2018). Drivers of tree planting and tree retention decisions among smallholder farmers in savanna landscapes of West Africa. *Journal of Environmental Management*, **219**: 215–225.
- Chirwa, P. W., Akinnifesi, F. K., & Franzel, S. (2019). Tree adoption by smallholder farmers in southern Africa: Drivers and constraints. *International Forestry Review*, **21**(3): 311–325.
- Damnyag, L., Acheampong, E., & Kwafo, E. (2020). Land tenure, tree planting and agroforestry adoption in West Africa. *Land Use Policy*, **92**: 104454.
- Doss, C., Meinzen-Dick, R., Quisumbing, A., & Theis, S. (2020). *Women in agriculture: Four myths*. IFPRI Discussion Paper 01967. Washington, DC: International Food Policy Research Institute.
- Franzel, S., Duguma, B., & Kipsat, M. (2016). Knowledge, perceptions, and adoption of agroforestry technologies in Kenya and Nigeria. *Agroforestry Systems*, **90**(6): 1019–1032.
- Garrity, D. P., Akinnifesi, F. K., & Ajayi, O. C. (2017). *Agroforestry in sub-Saharan Africa: A pathway to sustainable land management*. Nairobi: World Agroforestry Centre.
- Jamnadass, R., Place, F., Torquebiau, E., *et al.* (2015). Agroforestry trees for food security and nutrition. *Advances in Agroforestry*, **3**: 1–19.
- Jeminiwa, R., Usman, A., & Mohammed, A. (2021). Gender roles and agroforestry adoption among rural farmers in North-Central Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, **17**(1): 72–82.
- Kiptot, E., & Franzel, S. (2012). Gender, agroforestry adoption and tree benefits: Evidence from East Africa. *Small-Scale Forestry*, **11**(3): 347–361.
- Kiptot, E., & Franzel, S. (2019). Institutional factors affecting agroforestry adoption in Africa. *Agroforestry Systems*, **93**(2): 457–473.
- Kuyah, Stephen, Nyberg, Göte, Muthuri, Christopher N. (2016). Tree diversity and carbon storage in agroforestry systems in the Kenyan Highlands. *Agriculture, Ecosystems & Environment*, **221**: 93–106.
- Meijer, S. S., Catacutan, D., Sileshi, G. W., & Nieuwenhuis, M. (2015). The role of extension and advisory services in agroforestry adoption. *International Journal of Agricultural Sustainability*, **13**(1): 40–54.



- Mercer, D. E., & Miller, R. (2018). Demographic influences on agroforestry adoption. *Agroforestry Systems*, **92**(7): 173–182.
- Moyo, B., Chirwa, P. W., & Chifamba, P. (2022). Determinants of agroforestry adoption and tree species use among smallholder farmers in Zimbabwe. *Journal of Sustainable Agriculture and Environment*, **24**(1): 45–59
- Mulugeta, A. (2014). Determinants of smallholder farmers' adoption of agroforestry practice: Evidence from southern Ethiopia. *Journal of Agricultural Extension and Rural Development*, **6**(8), 217–225.
- Mustapha, R. I. & Jimoh, S. O. (2012). *Farmers' preferences for tree species on agroforestry systems in Ijebu North LGA, Ogun State, Nigeria.* (repository.ui.edu.ng)
- Nwachukwu, I., & Onuekwusi, G. C. (2017). Effectiveness of radio in disseminating agricultural information to farmers in Nigeria. *Journal of Agricultural Extension*, **21**(1): 65–77.
- Nyaga, J. M., Dougill, A. J., & Stringer, L. C. (2015). Farmers' perceptions of agroforestry benefits and constraints in a semiarid rural landscape of Kenya. *Agroforestry Systems*, **89**(5): 829–842
- Ogunjinmi, A. A., Oladipo, E. O., & Oyeyemi, A. L. (2020). Awareness and adoption of improved agroforestry practices among farmers in Southwest Nigeria. *Journal of Agricultural Science*, **12**(9): 74–83.
- Oladele, O. I. (2015). Effect of information dissemination on agricultural technology adoption in Nigeria. *African Journal of Agricultural Research*, **10**(6): 4263–4271.
- Pattanayak, S. K., Mercer, D. E., Sills, E. O., & Yang, J. C. (2017). Agroforestry adoption: Insights from attitudinal studies. *Ecological Economics*, **131**: 252–261.
- Place, F., Torquebiau, E., & Kalinganire, A. (2017). Tenure, trees and agroforestry: Lessons from Africa. *Agroforestry Systems*, **91**(3): 641–657.
- Reang, D., Barik, N., & Das, A. (2024). Farmers' perception and adoption of agroforestry practices in Northeast India. *Indian Journal of Agroforestry*, **26**(1): 34–47
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.
- Sileshi, G. W., Akinnifesi, F. K., Ajayi, O. C., & Place, F. (2014). Bioeconomic analysis of *Faidherbia albida* agroforestry. *Agroforestry Systems*, **88**(2): 357–372.
- Sinclair, Frances L., Coe, Rachel, Sileshi, G. W., & Ong, C. K. (2019). Enhancing agroforestry uptake: A synthesis of institutional barriers and opportunities from evidence across scales. *Agroforestry Systems*, **93**(6): 2143–2160.
- Steger, C., Mahop, M., Jensen, J. R., & Mertz, O. (2023). Gendered preferences and socio-cultural drivers of tree species selection in Central African mosaic agroforestry landscapes. *Agroforestry Systems*, **97**(3): 563–579.
- Tama, A. Y., Madaki, M. Y., Manourova, A., Mohammad, R. K., & Lojka, B. (2025). Farmers' use and preferences of agroforestry trees in Bauchi State, Nigeria. *Agroforestry Systems*, **99**(44): 234–243.
- Umeh, G. N. (2024). Distribution of Agroforestry Species in Southeast Nigeria. *Journal of Agricultural Science*. (ccsnet.org)
- Zomer, Robert J., Trabucco, Antonio, Coe, Michael T., Place, Frank, van Noordwijk, Meine, & Singh, Vinay. (2016). Tree cover and restoration opportunities in agricultural landscapes at global scale. *Scientific Reports*, 6, Article 29987